VEGETATION OF GREAT ISLAND, THREE KINGS GROUP, IN 1963

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ABSTRACT

New maps are presented for the quadrats established in 1946 when goats were exterminated on the island The composition of the canopy on the two forested quadrats is now changing, mainly through additions of *Melicytus ramiflorus* and *Meryta sinclairii*. A shrubbery of *Leptospermum ericoides* covers most of the quadrat that was laid down in grassland. Much of the island is less altered than the quadrats, so that *Leptospermum ericoides* still regenerates in some small forest windthrows, but there is widespread suppression of this and other arborescent species by the shrub *Coprosma rhamnoides* or by dense herbage.

In 1889 goats were liberated on Great Island, the largest of the Three Kings Islands. They perhaps joined a small herd surviving from the days of Maori settlement. Certainly they multiplied, and pressed so hard on the vegetation that by the 1930's the island's once rich and unique forest, which might in the course of almost a century since the departure of the Maoris have partially regained its character, was reduced instead almost entirely to kanuka (*Leptospermum ericoides*)[1]. At the plea of the staff of Auckland Museum, who have maintained a special interest in the group since Cheeseman made the first botanical exploration (Cheeseman, 1888), the goats were completely exterminated in 1946 by staff of the Wild Life Branch of the Department of Internal Affairs. E. G. Turbott, from the Museum, accompanied this party and took the opportunity to map three permanent quadrats so that recovery of the vegetation could be followed quantitatively (Turbott, 1948). Quadrat II was chosen as a fair sample of light forest of kanuka, and the other two as atypical extremes: quadrat I is in a moist valley in which a few representatives of the original mixed forest had survived, while quadrat III is exposed near a cliff top and was covered only with a sparse turf.

Auckland Museum mounted an expedition to the Three Kings in 1951 and devoted the December number of these Records to its findings. In the article there on Turbott's quadrats (Holdsworth, 1951), the hope was expressed that someone would be found to take a further census of the plant cover every five years. In fact plans were made to do so, but it was not until December 1963 when H.M.N.Z. Navy kindly placed the patrol launch "Paea" (Lt. Commander D. Davies, R.N.Z.N.) at the service of an expedition from Wildlife Branch of Internal Affairs, that these were realised—nearly 13 years since the last survey, and nearly 18 years since the goats were eliminated. As will appear, however, it is fortunately almost certain that no critical stage in the regeneration has been missed in the interval.

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[1]Nomenclature follows the New Zealand floras of Allan (1961) for dicotyledons and ferns and of Cheeseman (1925) for monocotyledons, except where a reference is given.

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General

Turbott intended Quadrat II to be a sample of the predominant vegetation of Great Island. So it still appeared to be in 1951, but it is becoming evident that it is transitional between the usually dry kanuka forest and the moister and richer valley forest below, typified by Quadrat I. It is unfortunate then, that we have not had a good sample of the ordinary forest under observation and the follwing impressions are intended to remedy the deficiency:—

From a distance, most of the forest looks very much as it did in 1951. Looking down from above, the kanuka canopy shows the same uniform cover and rather billowing texture that it did in 1946 (Baylis, 1948, fig. 5). Only locally are there variations, of which that provided by the pohutukawa (*Metrosideros excelsa*) grove is the most prominent because of extra height. It is not new, but it is extending, and seedlings in the adjacent bare or grassy areas (Baylis, 1951, figs. 4 and 5) have produced bushes that are now in flower. It is only in moister valleys, and on slopes with deep soil well fertilized by sea birds, that a new element appears in the canopy: a sprinkle of dark glossy crowns of puka *(Meryta sinclairii)* among the greyish green of the kanuka. Only very locally, e.g. immediately to the east and north of the isthmus, is the replacement of kanuka by puka anywhere near complete. Most of the kanuka, on the contrary, appears more vigorous than in 1951. In Quadrat II some standing trees were recorded as dead. But a limb or so must have retained an undetected tuft of foliage. In 1963 we marked old trees very much alive in some of these positions. It is still true, as it was in 1951, that kanuka is nowhere regenerating on Quadrats I and II, but we did, in the upper Tasman Va., for example, come across this species continuing to re-establish in small clearings where competition from other tree species or from vigorous herbage was lacking. But the appearance of rejuvenescence elsewhere is due mainly to increased leafiness of the old trees. The goats did not directly interfere with their crowns or bark, but it is likely that the ageing trees have responded to the absence of trampling, a general closing of the plant cover, and perhaps, an increased return of nutrients by an enlarged gull population.

Below the kanuka canopy, change is everywhere evident. Over most of the eastern plateau and on the ridge between the Tasman and Castaway Valleys the spaces between the kanuka trunks have filled with an almost impenetrable thicket of divaricating *Coprosma rhamnoides*. The light sandy soil of the eastern plateau (Battey, 1951, pl. 9) seems hostile to woody species other than manuka *(Leptospermum scoparium)*, kanuka, *Coprosma rhamnoides*, and the occasional mingimingi (*Cyathodes fasciculatus*). The undershrubs prevent regeneration of *Leptospermum*, and their own dense but lower canopy is here and there emerging to survive full exposure. In the areas where *C. rhamnoides* is less aggressive, young cabbage trees *(Cordyline kaspar)*, puka and Three Kings coprosma *(Coprosma macrocarpa)* are widespread but only locally abundant. The steepest and shallowest soils appear to have deteriorated under kanuka so that their fertility and water retaining capacity are unfavourable for other trees.

Where the density of woody plants has increased, the development of ground cover has been checked, but on gentle slopes, valleys, and hollows with deep soil, herbs so luxuriate as to have a reverse effect. The sedges, *Scirpus nodosus*, *Carex virgata* and *C. testacea* are still the most

important generally, but *Dianella intermedia* is often conspicuous. *Pratia (Colensoa) physaloides,* on the other hand, has declined since 1951, and good banks of it are now only to be found at its original stations along the Tasman Stream. Ferns, especially *Blechnum capense,* are plentiful in the lower Tasman Valley and, along with the preceding species, they are excluding tree seedlings from openings in the ancient kanuka canopy. This is so generally true that it is still not possible to predict the composition of the new forest that will eventually fill the Tasman Valley.

On the whole, there has been no radical qualitative change in the composition of the island's plant cover in the 13 years since the last survey. Quantitative adjustments between the species have undoubtedly occurred, but these we can only comprehend on the Quadrats.

Finding the Quadrats

Turbott anticipated that it would become more and more difficult to find the plots as the forest recovered, and was careful to leave (1948) detailed directions for locating them from prominent landmarks. In 1951, even with Turbott himself there to help, it was not easy to find the corner pegs. On Quadrat I there was no longer a clear line of sight for more than a few yards, and through difficulty in keeping the boundaries straight, errors were undoubtedly introduced. Accordingly, the corners have now been re-marked with 5-foot aluminium posts banded with orange paint. White p.v.c. circles have, in addition, been nailed to all the prominent trees close to, but within, the boundaries. These markers are at shoulder height and face outwards.

Turbott used a prominent rock as a first direction to the valley in which Quadrats I and II both lie. This is still visible from the top of the isthmus between the landing beaches, but can no longer be kept in view after one leaves the saddle. There are similar rocks on the same face, so it is easy to be led wide of the quadrats by travelling on the bearing he gives, but from the wrong rock. We have now marked the proper rock with a white p.v.c. *hexagon* facing the saddle. Even when the rock has been reached, it is difficult to keep a straight course through the undergrowth, and we had particular trouble in finding Quadrat II. So we have laid a trail of these hexagon markers from the first tree across the saddle, to Quadrat I, and thence to Quadrat II. The approach is not direct but attempts to keep an easy grade, curving down the right side of the saddle ridge, skirting the base of the line of rocks and so to the SW. corner of Quadrat I. The post at this corner is numbered "1" and is shown on the top left hand corner in Turbott's and our charts. The line of p.v.c. circles to the left should then be followed to corner post "2" (NW. corner, top right of charts) and from there the hexagons continue over some rocks, more or less straight to post "8" (S. corner, bottom left of charts) of Quadrat II.

On reaching the vicinity, one can still easily recognise the country and find the marker rock near Quadrat III; but the rock above Castaway Valley from which Turbott gave directions for crossing the island is no longer visible and it is therefore difficult to strike the saddle between Castaway and Tasman Valleys. So we also intended to define a trail between the two valleys to Quadrat III; but only the first 100 yards or so from the Depot were laid. A fourth line of hexagons leads to the specimen of *Plectomirtha*

baylisiana, but this only begins at the edge of the cliff about the position of the encircled "2" on the map published by Baylis (1948 p. 242).

The Quadrats

Methods

As in 1951, each of the quadrats was divided by a grid of strings and the position of plants mapped by eye within the squares so formed. These were 2 metres each way on Quadrat I and 1 metre on the smaller ones. With two workers, it was easier this time to keep the strings straight where thickets blocked the line of sight. Even so, on the boundaries, the inclusion of some marginal trees had to be arbitrarily decided, and we have at times departed from both Turbott's and Holdsworth's previous boundaries. Except for some doubt along the SE. boundary of Quadrat II, however, we have been able to reconcile our records with those of Holdsworth by identifying the individual trees. The side lines should, from now on, be stabilised by the plastic markers.

On Quadrat I we recorded individual plants, even of herbs when they were discrete; but on Quadrat II where the ground cover is more evenly mixed, and on Quadrat III where most are annuals, we have usually only indicated absence or presence of the herb species in each square. On Quadrats I and II, the girth of trunks over one inch diameter was measured (at breast height) if the specimen was one established since 1946.

Quadrat I, the Canopy (Plate 27)

Holdsworth's chart of this plot in 1951 shows a canopy of 81 trees (erroneously stated as 80 in the text), with kanuka contributing most of the cover. An equal number of cabbage trees was involved but their tufted crowns made them relatively unimportant. Smaller numbers of *Melicope, Litsea, Paratrophis* and one each of *Melicytus* and *Pittosporum* made up the total. These were all old trees, the same as appear in Turbott's chart for 1946, except for sixteen kanukas which had died in the interim. We now show these originals further reduced to 62, mainly through the death of another eleven kanuka (Table 1). However, the canopy has now been reinforced by young trees, none of which was considered of canopy rank in 1951. By far the most numerous are *Melicytus,* equal in number by themselves to the whole complement of canopy trees in 1951, but not yet contributing more than 29% of the basal area of the new tree trunks (Table 3). Next, though only half as numerous, are kanuka. Unlike the *Melicytus* these are not new seedlings since 1946 but the survivors of competition within the two thickets shown by Turbott along the NE. boundary. *Entelea,* although next on the list in Table 1, is presumably of no permanent importance. Already more than one generation of this ephemeral tree has been completed since 1946, judging by the dead specimens on the plot, and the published record of a life span of 6-9 years (Millener, 1947). The only other tree calling for comment is *Meryta,* with 15 crowns now in the canopy, contributing 13% of the basal area (Table 3).

Quadrat I, the Undergrowth (Plates 28 and 29)

Among the younger trees, we recorded specimens under 15 cms as seedlings. These are not tabled separately because they were few and most (i.e. 28) were *Paratrophis.* Of these none except the group in the N. corner

may actually have come from seed, for like other figs this shrub suckers freely. The rarity of new seedlings indicates a great reduction in regeneration on this plot, for we recall that seedlings were abundant in 1951, and the size distribution of woody plants then tailed off the other way. There can be little doubt that the deep shade now cast, for which the new *Melicytus* canopy is mostly responsible, has practically stopped colonisation.

The most numerous saplings are again *Melicytus,* with *Litsea* and *Melicope* next, but far behind (Table 1). In comparing "under canopy" totals for 1951 and 1963 saplings attaining the canopy in this interval (bracketed) must be taken into account. A contrast between *Leptospermum* and *Meryta* is then apparent. About half the *Leptospermum* are now trees, and most of the rest have been eliminated. All the *Meryta* saplings are now trees, but a new generation maintains its numbers in the understory. *Coprosma rhamnoides,* so abundant in adjacent parts of the island, has almost exactly the same representation as in 1951.

Quadrat I, Lianes Clematis is mainly confined to the clumps marked by Turbott. *Tetrapathaea* and *Muehlenbeckia,* on the other hand, have greatly increased their territories, contributing both to the canopy and, in the two open spaces, to the ground cover.

Quadrat I, Herbs The variety of herbs is considerably greater than in 1951, when not more than a dozen or so species were represented.* Now we have 21 listed in the key to Plate 29. None of these new arrivals gives rise to much surprise, however. They have all been recorded previously from some part of Great Island (Baylis, 1958) except *Asplenium lucidum.* Even that is known from the smaller islands. Although so many more species are represented, the density of ground cover overall has decreased since 1951. The whole of the W. quarter is substantially bare underfoot. The extensive areas of almost pure sedge in the S. quarter and NE. half are still noticeable, but obviously diminished in extent. The solid banks of *Pratia (Colensoa)* along the water-courses are much reduced in width, and noticeably in purity.

Quadrat II (Plates 30 and 31)

It was said of Quadrat II in 1951 that, superficially, little change had occurred in the general appearance. We have to record the opposite now; it has changed beyond recognition, mainly because of the rampant growth of passion vine, only three plants of which were recorded in 1951. *Clematis* which does not appear to have spread on Quadrat I has, all the same, spread to Quadrat II and these lianes together with *Meryta* give the impression that this site is damper and lusher than we had supposed. Indeed, it looks today not unlike parts of Quadrat I in 1951.

Of the twenty old kanuka providing the canopy in 1951, thirteen are still alive including three apparently raised from the dead, as earlier mentioned (Table 2). Six young kanukas have now also added their crowns to the canopy, and with seven smaller ones account for the young kanukas present in 1951. The single old cabbage tree is still there, but appears to have lost its original crown and regrown from the base. It has now been

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* The *Haloragis* indicated in Fig. 19 (1951) was actually *H. erecta.*

joined in the canopy by no less than twenty-three new ones. These cabbage trees are the most obvious additions (Plate 34b), but the nine *Meryta* may prove in the long run more significant. The single canopy specimens of *Paratrophis* and *Melicytus* are also worthy of mention because they too are new arrivals since the extinction of the goats.

Of the woody plants which do not yet reach into the canopy, the most noticeable is *Coprosma rhamnoides* of which we counted a total of 166, double that present in 1951. But it is less dense than it becomes on the sandy soil not far distant and it is disguised by an overgrowth of vines (Plate 33a, b). *Paratrophis* and *Litsea* were recorded in 1951, undoubtedly derived from parents down the valley. Only one of the former and two of the latter have survived, but they have now been joined by *Pittosporum* and *Geniostoma*. The single seedling of *Melicope* that Turbott saw at the time the goats were shot, is still alone and has grown to a height of three feet in the eighteen years intervening.

In the ground cover there are fewer significant changes to record. Practically the whole area, except for patches in the deepest shade, is still closely covered with sedge and, as before, these are everywhere pervaded with the fern *Doodia media*. The single plant of *Davallia tasmani* has disappeared, but *Athropodium* which also was in 1951 represented by one plant, now has some half dozen distributed in the north quarter. *Erigeron* and *Haloragis* were not recorded this time but *Asplenium lucidum, Pteris comans, Scirpus nodosus, Poa anceps* and *Pratia physaloides* have come in and may be expected to be more permanent.

Quadrat III (Plate 32)

As shown in the superscription, the diagram of this plot is rotated 90° from the corresponding charts in Turbott and in Holdsworth, 1951. This makes the slope of the land lie down the page as with the other two quadrats.

The area in which this plot lies appears not much changed since 1951. However, low growing kanuka, which had only just reached the plot then, has been steadily creeping up the slope, becoming confluent on the quadrat and leaving little open ground. It does not provide an even cover as might be assumed from the diagram, but has a lumpy appearance, seemingly composed of a mosaic of two genetically distinct types: one trailing, and the other making erect rounded bushes (Plate 35a). The tallest of the latter measured about a metre.

The closing up of the kanuka has meant a considerable reduction in the number of other species present, for the ground beneath is usually bare (Table 4). It is evident, however, that its shade does not exclude *Scirpus nodosus* which has indeed increased since 1951, or *Coprosma rhamnoides*, which unrecorded then, now has 89 plants within the quadrat, mostly well beyond the seedling age. Indeed, it is very probable that this *Coprosma* requires the kanuka as a nurse, for it is absent from the uphill third of the quadrat which the kanuka has only recently covered (Plate 31). There is also a progression downhill in size of *Coprosma*. None is emergent (the tallest measured 80 cm.) and it would appear that this area is reproducing in miniature the association of the drier parts of the island: kanuka forest with *Coprosma* as an understory, and almost bare ground beneath. In one patch close to an open space there is a ground cover of

Carex testacea, again just as on the island generally. Two other elements, *Cordyline* and *Melicope*, which have appeared since 1951 may initiate a radical change in this part of the island. As yet, they are battered isolated specimens but the *Cordyline* is already flowering.

In the previous account of this quadrat (Holdsworth, 1951) a table was given of the frequency of herbs in the grassy sward, based on their presence in the 15 squares along the SW. boundary which were all that could then be completed. In 1963 we made observations for all squares but the majority of them, of course, have no sward in them and Table 4 includes an analysis of those 15 grassy squares nearest to the SW. side, with 1951 figures for comparison. A suggestion here, that what is left of the sward is poorer in species than it used to be, is confirmed in the list (Col. B) for the whole quadrat, from which *Sonchus oleraceus, Oxalis corniculata, Cotula australis, Dichondra repens, Hydrocotyle novae-zelandiae* and *Zoysia matrella* are missing. The last name is particularly noteworthy because Turbott originally designated the plot as an area of "typical *Zoysia* sward". It will be noticed, in compensation, that Table 4 takes in a number of new perennials, and it is satisfactory to record that alien plants in the vegetation are diminishing as a consequence of the elimination of the alien animals.

Conclusions and Forecasts

Our previous projections of the course of development of stable vegetation on Great Island have changed somewhat. When knowledge of the smaller islands was still superficial, Baylis (1948) assumed that the vegetation of Great Island alone had been seriously modified. As two distinct types of forest could be seen on the smaller ones, it followed that the largest island must also have supported both types in its virgin state. The two types seemed to show zonation: a coastal zone of *Meryta* forest and an inland zone of mixed forest with a rich flora including most of the endemics. By 1951, however, it seemed unlikely that *Meryta* forest was permanent, even close to the sea. Evidence for Maori occupation of both the SW. and NE. Islands was accumulating, and in 1958 Baylis stated that "there is nothing to support (my original) opinion that puka was permanently dominant on the seaward margin (of Great Island)". On the SW. island where the most extensive pure *Meryta* forest is to be seen, its regeneration is tardy and dependent on the appearance of a considerable canopy gap, although the seedlings are tolerant of the shade of kanuka on Great Island. Where trees of karaka (*Corynocarpus laevigata*) or parapara (*Heimerliodendron brunonianum*) occur, their seedlings establish before these gaps develop and usurp the place of *Meryta*, a process which, however slow, must ultimately eliminate it as a canopy tree. Baylis (1958) also suggested that pohutukawa (*Metrosideros excelsa*) might be a permanent dominant on steep or rocky sites where its limbs could sag to the ground and root again so that each tree is potentially immortal.

There is a small grove of pohutukawa on Great Island and it is rapidly spreading on to Bald Hill but the circumstances are unusual in that the ground was quite open and mainly broken rock. We have no record of pohutukawa appearing on any of the quadrats and it is not expected except on the bare ground remaining in Quadrat 3. As the general vegetation of Great Island, pohutukawa forest does not now seem a possibility. The species is plainly strongly light demanding throughout its life, and the

situation in parts of South-West Id. where puka grows beneath a pohutukawa canopy must result from the invasion of pohutukawa forest by a puka understory. This is now occurring in the old grove on Great Island (Plate 35b).

The spread of puka over South-West Id. was favoured by a fertile soil (Baylis, 1958). In Great Id. it is not being so generally encouraged. But we hesitate to predict any permanence for the relatively small species that are for the time being excluding tree seedlings, notably *Coprosma rhamnoides* on the drier soils particularly on the eastern limb of the island, and the dense growth of sedge and fern in windthrows in the Tasman Valley. Yet some of the species which owe their chance to dominate to the sudden end of goat browsing may prove unexpectedly persistent, like the patch of bracken on North-East Id. (Baylis, 1958).

TABLE 1:

Quadrat 1. Numbers of woody plants. Canopy trees are all survivors of the 1946 canopy except those enumerated in brackets under 1963. Nearly all plants recorded under the canopy in 1963 exceed 30 cm in height.

	IN CANOPY			UNDER CANOPY		
WOODY SPECIES:	1963	1951	1946	1963	1951	1946
Brachyglottis arborescens	(1)				2	
Coprosma repens				2		
Coprosma rhamnoides				30	27	9
Cordyline kaspar	28	34*	29	9	7	
Entelea arborescens	(20)			8	3	
Geniostoma ligustrifolium	(3)			17	3	
Hiemerliodendron brunonianum				3		
Leptospermum ericoides	23 (39)	34	50	7	73	43
Litsea calicaris	4 (1)	4	4	75	52	?
Melicope ternata	4 (5)	5	5	39	51	15
Melicytus ramiflorus	1 (81)	1	1	210	238	
Meryta sinclairii	(15)			16	15	
Myoporum laetum				2	5	7
Paratrophis smithii	1 (2)	2		46	5	
Pittosporum fairchildii	1	1		16	4	
TOTALS	62 (167)	81	89	480	485	74

* probably the original 29 plus 5 not previously included within boundaries of plot.

TABLE 2:

Quadrat 2. Numbers of woody plants. Canopy trees are all survivors of the 1946 canopy except those enumerated in brackets under 1963. Nearly all plants recorded under the canopy in 1963 exceed 30 cm in height.
p—present but not counted.

	IN CANOPY			UNDER CANOPY		
WOODY SPECIES	1963	1951	1946	1963	1951	1946
Coprosma rhamnoides				166	75	p
Cordyline kaspar	1 (23)	1	1	5	17	
Geniostoma ligustrifolium				1		
Leptospermum ericoides	13 (6)	20	46	7	12	
Litsea calicaris				2	4	
Melicope ternata				1	1	1
Melicytus ramiflorus	(1)				2	
Meryta sinclairii	(9)			3	8	
Myoporum laetum					1	
Paratrophis smithii	(1)				3	
Pittosporum fairchildii				2		
TOTALS	14 (40)	21	47	187	123	1

TABLE 3:

Quadrats 1 and 2, Dec., 1963. Total basal area* contributed by canopy trees first recorded in 1963, excluding any below 2.5 cm. diam. The figure in brackets is the percentage of the total.

SPECIES	BASAL AREA CM² Quadrat 1		Quadrat 2	
Brachyglottis arborescens	266	(3)		
Cordyline kaspar			356	(38)
Entelea arborescens	1334	(14)		
Geniostoma ligustrifolium	178	(2)		
Leptospermum ericoides	3488	(37)	307	(33)
Melicope ternata	206	(2)		
Melicytus ramiflorus	2693	(29)	79	(9)
Meryta sinclairii	1193	(13)	182	(20)
Paratrophis smithii	54	(1)		
TOTALS	9412	(100)	924	(100)

* Area of trunk cross section at breast height (1.4m.).

TABLE 4:

Quadrat 3—herbs. Number of metre squares on which each species was present in 1963:

A—for the 15 grassy squares nearest the SW boundary, with figures for 1951 in brackets.

B—for all 225 squares.

SPECIES	A.		B.
Adianthum hispidum			12
Agropyrum kirkii Zotov	6	(0)	32
Aira caryophyllea L.	10	(10)	33
Aira praecox L.		(8)	2
Carex breviculmis	11	(1)	42
Carex testacea			97
Centella uniflora	5	(15)	39
Chloris truncata R. Br.			2
Cirsium vulgare (Savi) Ten.	1	(0)	5
Cotula australis		(1)	
Cyathodes fraseri	2	(0)	17
Davallia tasmani			3
Deyeuxia crinita	6	(15)	83
Dianella intermedia			3
Dichondra repens		(1)	
Doodia media		(1)	50
Echinopogon ovatus			6
Erigeron canadensis L.		(1)	6
Gnaphalium collinum Lab.	15	(8)	71
Haloragis erecta			2
Hydrocotyle novae-zelandiae		(1)	
Hypochoeris radicata Lab.	15	(5)	96
Microlaena stipoides			1
Moss	2	(0)	25
Notodanthonia sp.	11	(5)	89
Oplismenus undulatifolius			12
Oxalis corniculata		(3)	
Phormium tenax			1
Pteris macilenta			1
Scirpus nodosus	5	(0)	123
Sonchus oleraceus L.		(6)	
Thelymitra longifolia			1
Vulpia dertonensis (All.) Volk.	1	(10)	31
Wahlenbergia gracilis	3	(9)	11
Zoysia matrella		(3)	
TOTAL SPECIES	14	(18)	29

TABLE 5:

Quadrat III, Dec., 1963. Numbers of plants of *Coprosma rhamnoides* in strips 1 meter wide across the plot, arranged in order down the slope.

Strip	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Seedlings	—	—	—	1	1	7	9	3	11	2	—	—	2	—	—
Older Plants	—	—	1	—	—	—	—	—	1	16	19	4	7	2	3

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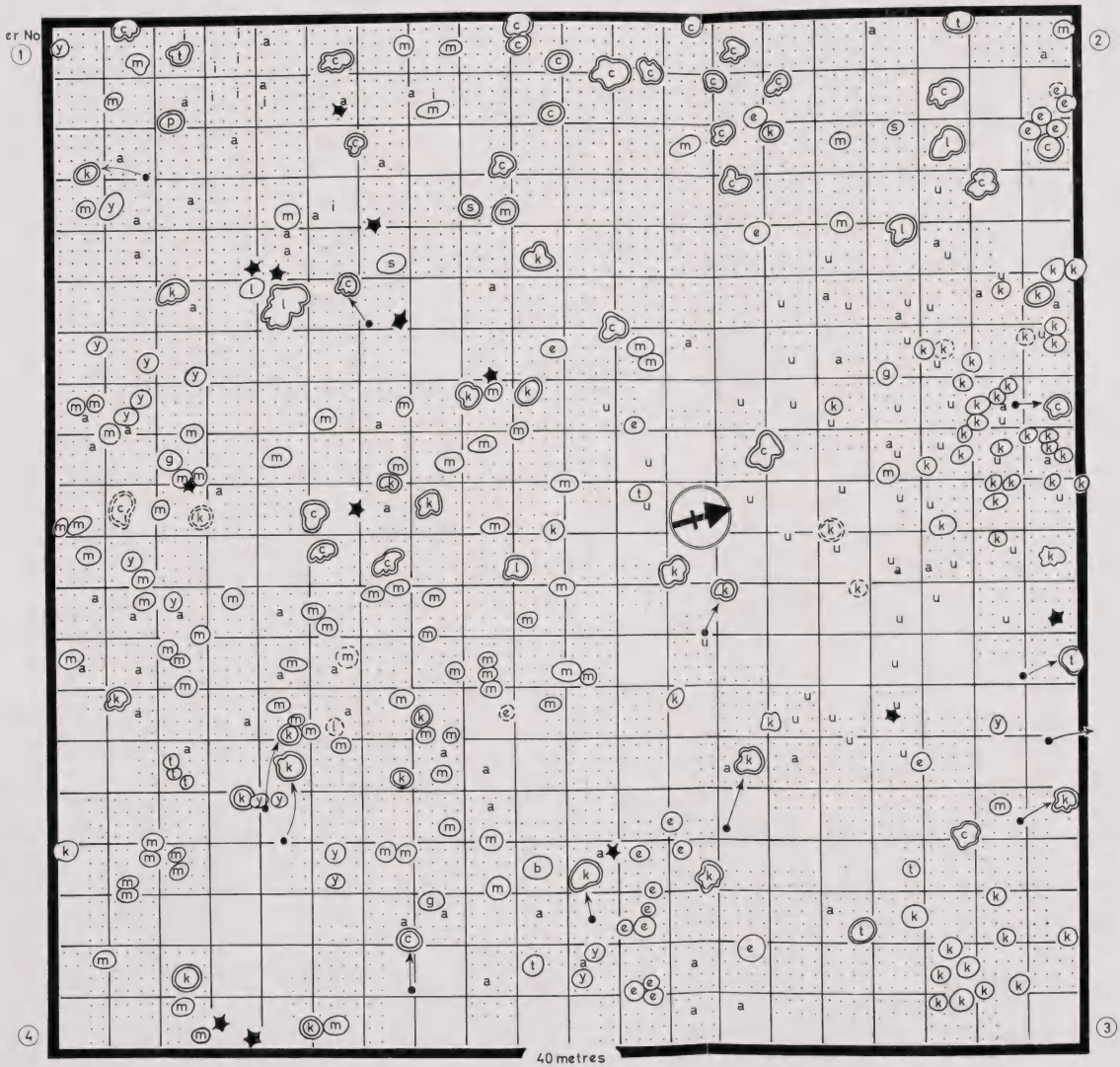
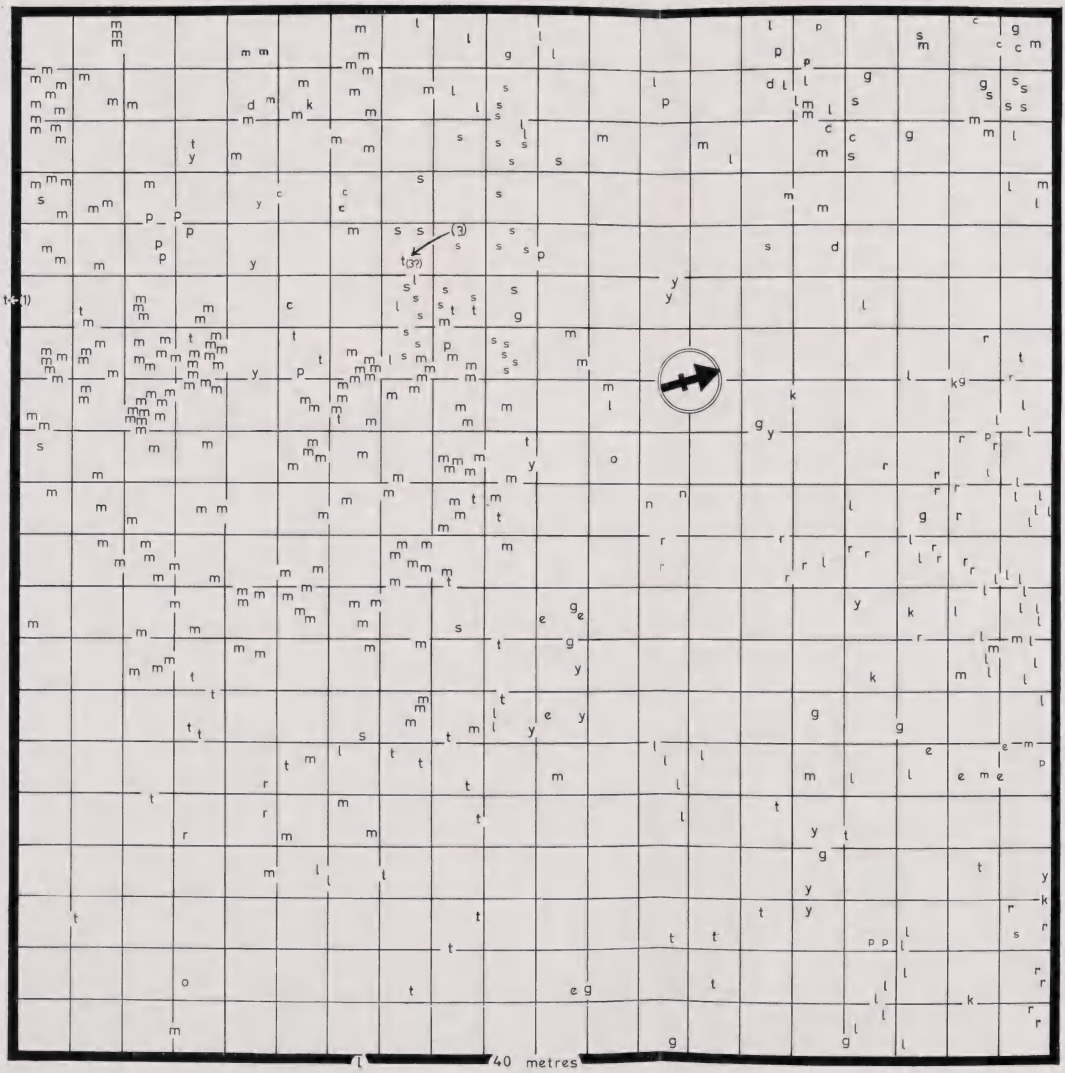


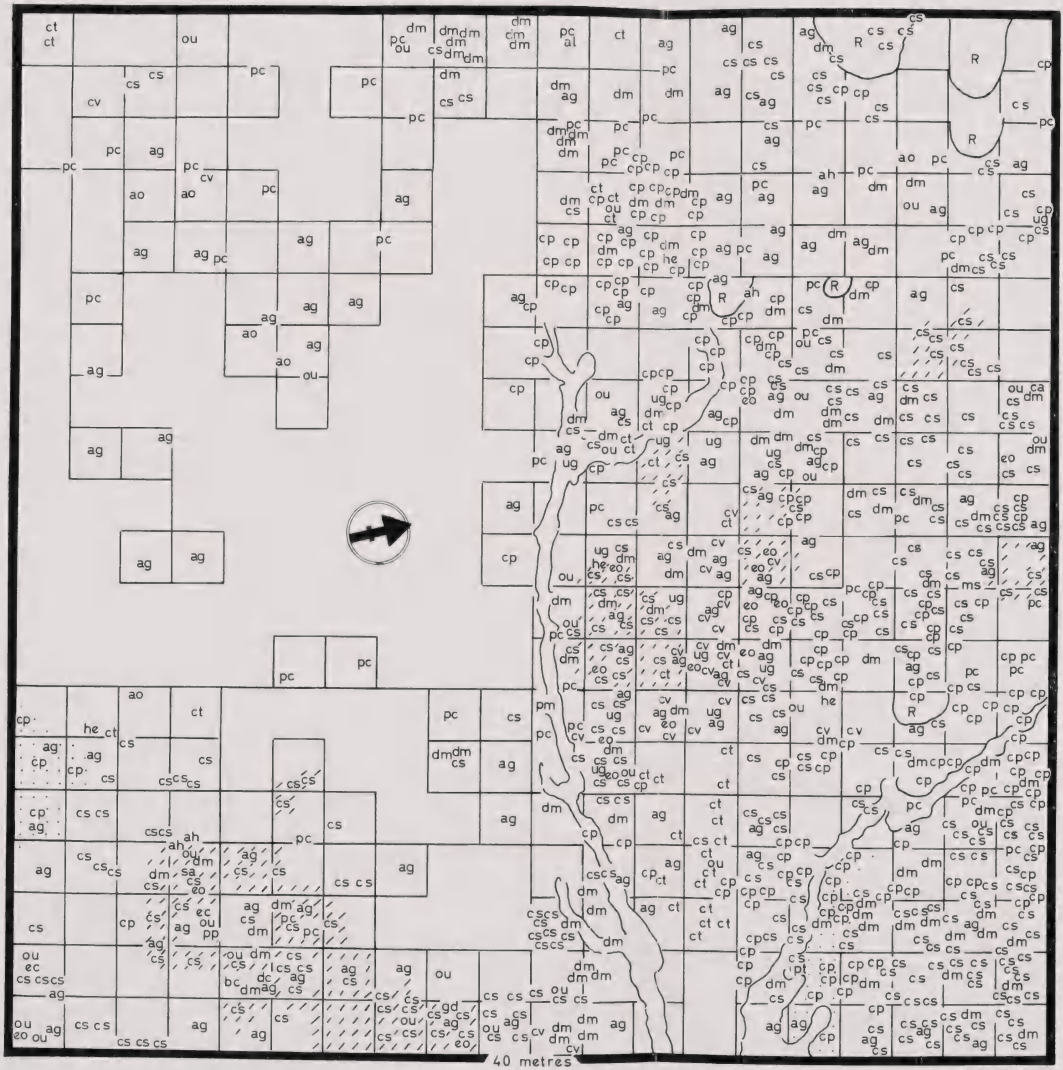
Quadrat I — canopy, 1963. Unstippled areas have no canopy. Original canopy trees indicated by double lines, trees entering canopy since 1951 by single lines, dead standing trunks by broken lines. Stars show sites from which a tree has disappeared since 1951. Arrows reconcile positions with those on 1951 map.

a. *Tetrapathaea tetrandra;* b. *Brachyglottis arborescens;* c. *Cordyline kaspar;*
e. *Entelea arborescens;* g. *Geniostoma ligustrifolium;* i. *Clematis paniculata;*
k. *Leptospermum ericoides;* l. *Litsea calicaris;* m. *Melicytus ramikorus;*
p. *Pittosporum fairchildii;* t. *Melicope ternata;* m. *Muehlenbeckia australis;*
y. *Meryta sinclairii.*



Quadrat I—young trees and seedlings (mostly exceeding 30 cm high), 1963. (1) and (3) are seedlings marked by Turbott (1947).

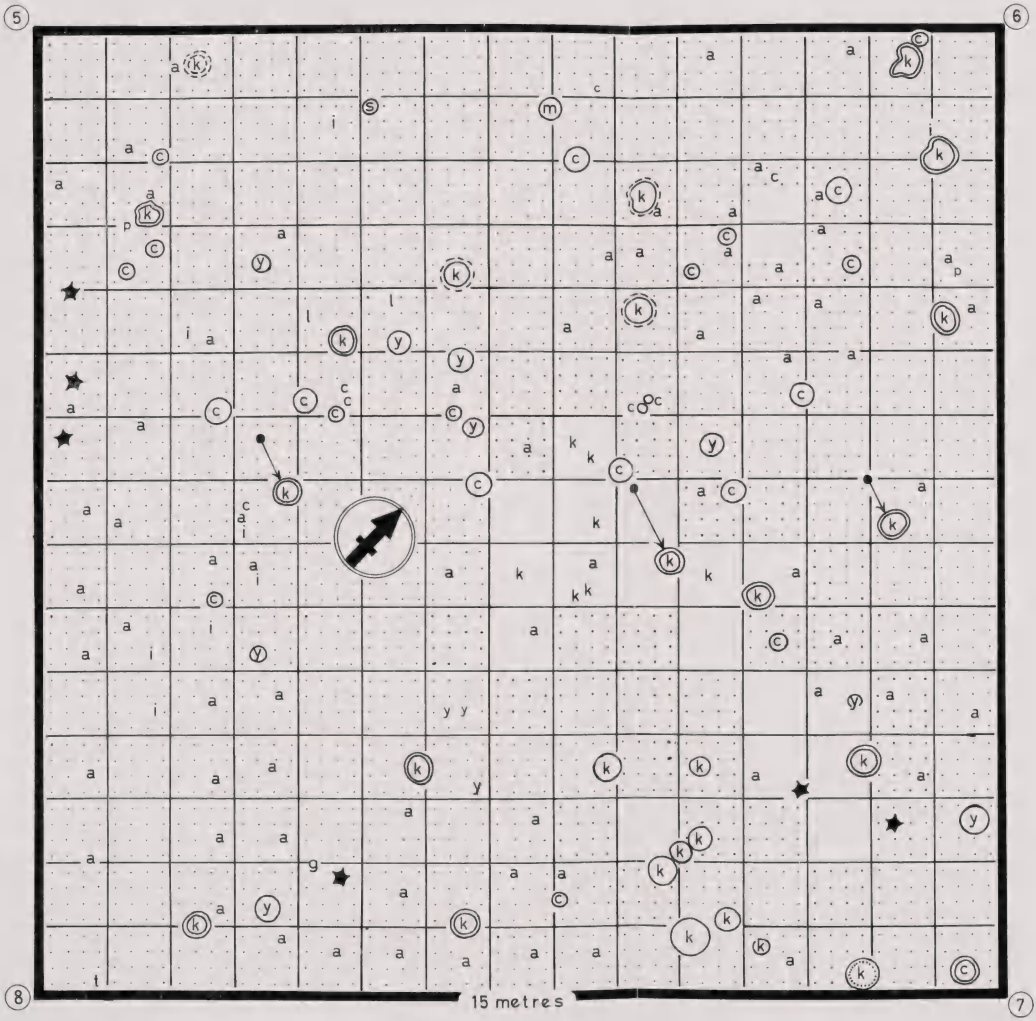
c. *Cordyline kaspar;* d. *Hiemerliodendron brunonianum;* e. *Entelea arborescens;* g. *Geniostoma ligustrifolium;* k. *Leptospermum ericoides;* l. *Litsea calicaris;* m. *Melicytus ramiflorus;* n. *Myoporum laetum;* o. *Coprosma repens;* p. *Pittosporum fairchildii;* r. *Coprosma rhamnoides;* s. *Paratrophis smithii;* t. *Melicope ternata;* y. *Meryta sinclairii.*



Quadrat I — herbaceous species.

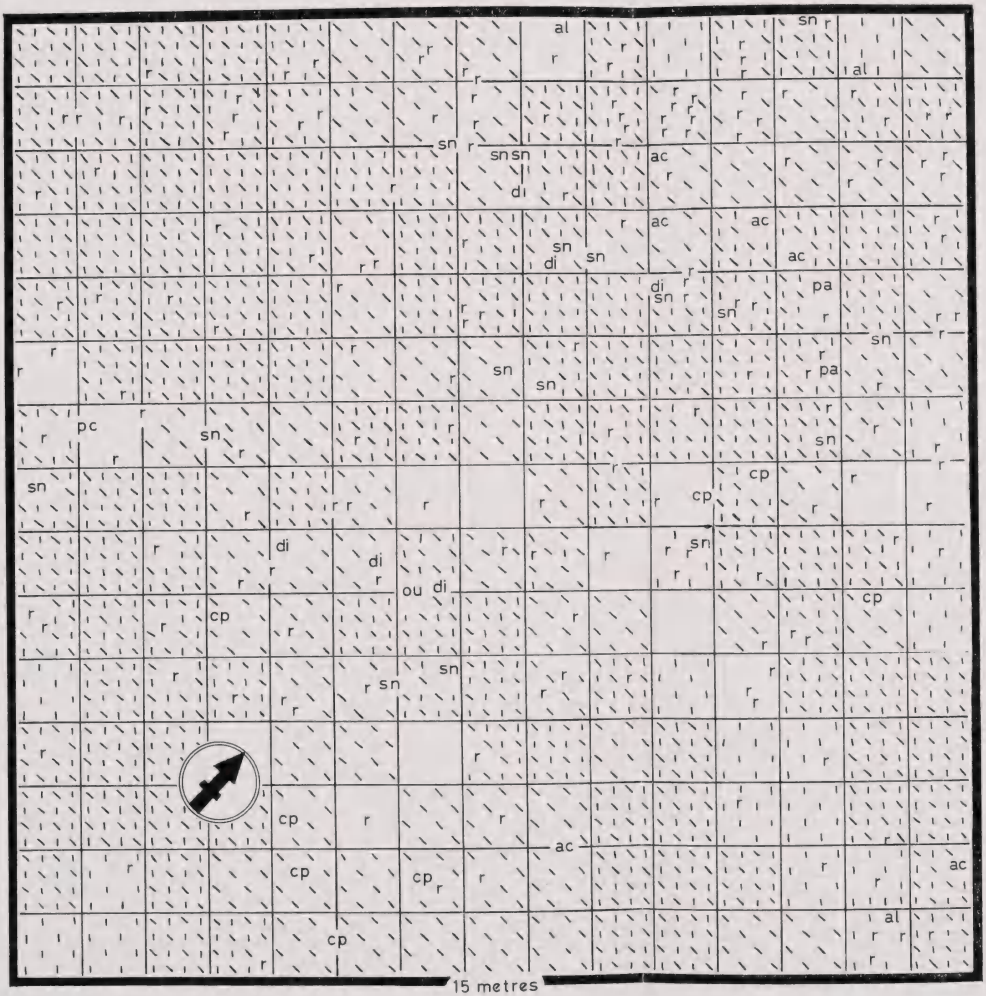
ag. *Tetrapathaea tetrandra* on ground; ah. *Adiantum hispidulum;* ao. *Asplenium obtusatum;* bc. *Bromus catharticus;* ca. *Centella uniflora;* cs. *Carex sp;* ct. *Carex testacea;* cv. *Carex virgata;* cp. *Pratia physaloides;* dc. *Deyeuxia crinita;* dm. *Doodia media;* ec. *Erigeron canadensis;* eo. *Echinopogon ovatus;* gd. *Geranium dissectum;* he. *Haloragis erecta;* ms. *Microlaena stipoides;* ou. *Oplismenus undulatifolius;* pc. *Pteris comans;* pp. *Physalis peruviana;* pt. *Pteris tremula;* R. Rock. sa. *Sicyos angulata;* ug. *Muehlenbeckia complexa* on ground.

Dots indicate *Pratia* was continuous, oblique dashes that sedge was continuous.

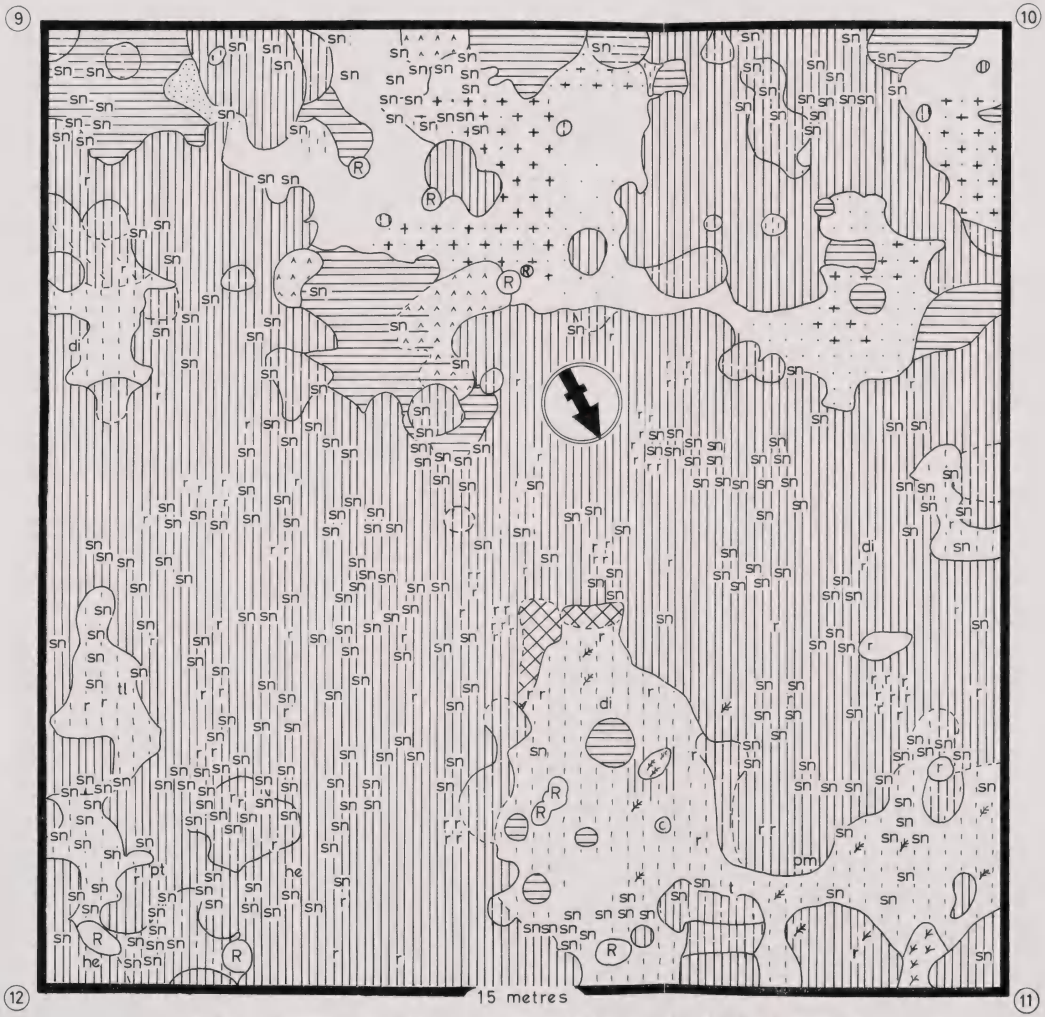


Quadrat II — trees and lianes both in and below canopy and the extent of canopy cover (stippled). Stars indicate sites of trees that have disappeared since 1951. Continuous double outlines indicate trees also recorded in 1951. Broken outer outlines indicate trees wrongly recorded as dead in 1951. Broken double outline indicates tree recently dead. Dotted inner outline indicates tree not included by boundary in 1951. No outline indicates seedling below canopy.

a. *Tetrapathaea tetrandra;* c. *Cordyline kaspar;* g. *Geniostoma ligustrifolium;* i. *Clematis paniculata;* k. *Leptospermum ericoides;* l. *Lissea calicaris;* m. *Melicytus ramiflorus;* p. *Pittosporum fairchildii;* s. *Paratrophis smithii;* t. *Melicope ternata;* y. *Meryta sinclairii.*



Quadrat II — undershrubs and ground cover. Squares with vertical dashes contain *Doodia media*. Squares with oblique dashes contain *Carex testacea*,
ac. *Arthopodium cirrhatum;* al. *Asplenium lucidum;* cp. *Pratia physaloides;*
di. *Dianella intermedia;* pa. *Poa anceps;* pc. *Pteris comans;* r. *Coprosma rhamnoides;*
sn. *Scirpus nodosus.*



Quadrat III rotated 90° from orientation in Holdsworth (1951) and Turbott (1948): Bars indicate *Leptospermum ericoides* — vertical where it is erect; horizontal where prostrate; interrupted where moribund; diagonal where it is dead. Vertical dashes indicate grass. Oblique dashes indicate sedge *(Carex testacea)*. Dots indicate lichens and moss. Crosses indicate *Gnaphalium collinum*. Oblique crosses indicate *Davallia tasmani*. Oblique double-barred crosses indicate *Adiantum hispidum*. Inverted Vs indicate *Cyathodes fraseri*.

c. *Cordyline kaspar;* di. *Dianella intermedia;* he. *Haloragis erecta;* pm. *Pteris macilenta;* pt. *Phormium tenax;* R. bare rock; r. *Coprosma rhamnoides;* sn. *Scirpus nodosus;* t. *Melicope ternata;* tl *Thelymitra longifolia.*

a, Quadrat II, Dec. 1963. View towards peg 6 - cf. Turbott (1948) fig. 9; Holdsworth (1951) fig. 13.

b, Quadrat II, Dec. 1963 - cf. Turbott (1948) fig. 10; Holdsworth (1951) fig. 14.

a, Quadrat II, Dec. 1963 - cf. Turbott (1948) fig. 11.

b, Quadrat II, Dec. 1963. Diagonal view of canopy from near peg 6.

a, Quadrat III, Dec. 1963 - cf. Turbott (1948) fig. 14; Holdsworth (1951) fig. 16.

b, Inside the pohutukawa grove, Dec. 1963; showing *Meryta sinclairii, Cordyline kaspar* and *Cortaderia fulvida*. There was no understory in 1948.